CVISN Guide to Top-Level Design

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Note

The Motor Carrier Safety Improvement Act was signed into law on December 9, 1999. This act established a new Federal Motor Carrier Safety Administration (FMCSA) within the U.S. Department of Transportation (DOT), effective January 1, 2000. Prior to that, the motor carrier and highway safety program was administered under the Federal Highway Administration (FHWA).

The mission of the FMCSA is to improve truck and commercial passenger carrier safety on our nation's highways through information technology, targeted enforcement, research and technology, outreach, and partnerships. The FMCSA manages the Intelligent Transportation Systems (ITS) / Commercial Vehicle Operations (CVO) program, a voluntary effort involving public and private partnerships that uses information systems, innovative technologies, and business practice re-engineering to improve safety, simplify government administrative systems, and provide savings to states and motor carriers. The FMCSA works closely with the FHWA ITS Joint Program Office (JPO) to ensure the integration and interoperability of ITS/CVO systems with the national ITS program.

BASELINE ISSUE

It is important to note that this is a baseline document. All sections included are complete and have been reviewed by JHU/APL, other DOT contractors, and state/federal government agencies. All comments received to date have been incorporated or addressed.

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Note: This document and other CVISN-related documentation are available for review and downloading by the ITS/CVO community from the JHU/APL CVISN site on the World Wide Web. The URL for the CVISN site is: **http://www.jhuapl.edu/cvisn/**

Review and comments to this document are welcome. Please send comments to:

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1. INTRODUCTION

The CVISN (Commercial Vehicle Information Systems and Networks) Guide to Top-Level Design shows the initial steps in the process of deploying CVISN in a state. For purposes of these guides, **top-level design encompasses setting the scope of the program, defining top-level requirements, and laying out an initial high-level design for the state systems.**

This is one in a series of guides. The other guides are available from the CVISN web site (http://www.jhuapl.edu/cvisn/).

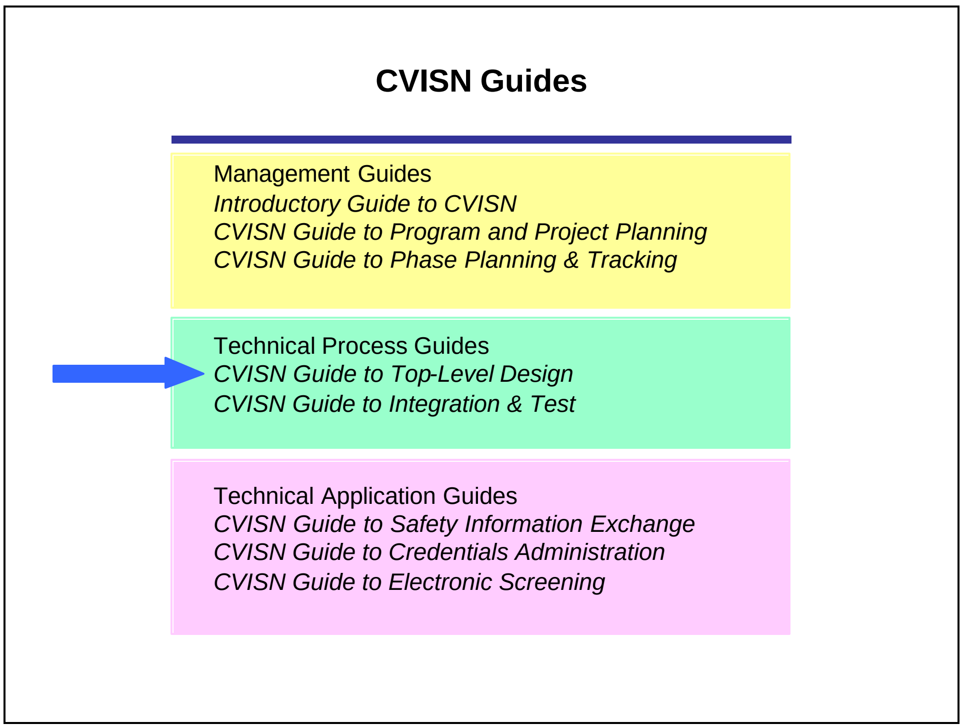

Figure 1-1. CVISN Guides

Subsequent chapters of this guide discuss the concepts, processes, and documentation associated with top-level design.

Reference 1 provides definitions of terms and abbreviations used in this document.

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2. WHAT IS TOP-LEVEL DESIGN?

In the *Introductory Guide to CVISN* (Reference 8), we defined "architecture" as the overall structure (elements and interfaces) and unifying design characteristics (principles, concepts, and standards) of a system. Often, systems engineers use "architecture" and "top-level design" as synonyms. In the CVISN context, though, it is useful to reserve "architecture" to apply to the generic CVISN architecture, and "top-level design" to apply to a state-specific design. **Thus, a state's CVISN top-level design is the structure of the systems and interfaces within the state and the principles, operational concepts, scenarios, and standards that shape the structure.** Top-level design is also a process. This guide explains the process and the results of that process that can be captured in a top-level design description document. The top-level design process encompasses setting the scope of the CVISN program in the state, defining top-level requirements, allocating new requirements to new or existing systems, defining interfaces among systems, and describing the physical computers and networks that will support the systems. Since CVISN top-level design is built on existing systems in the state, the top-level design process also focuses on how to use or change the existing systems to support the CVISN operational concepts and scenarios.

Figure 2-1 shows how the National ITS (Intelligent Transportation Systems) Architecture, CVISN Architecture, and International Border Clearance (IBC) Architecture formed the foundation for future deployments.

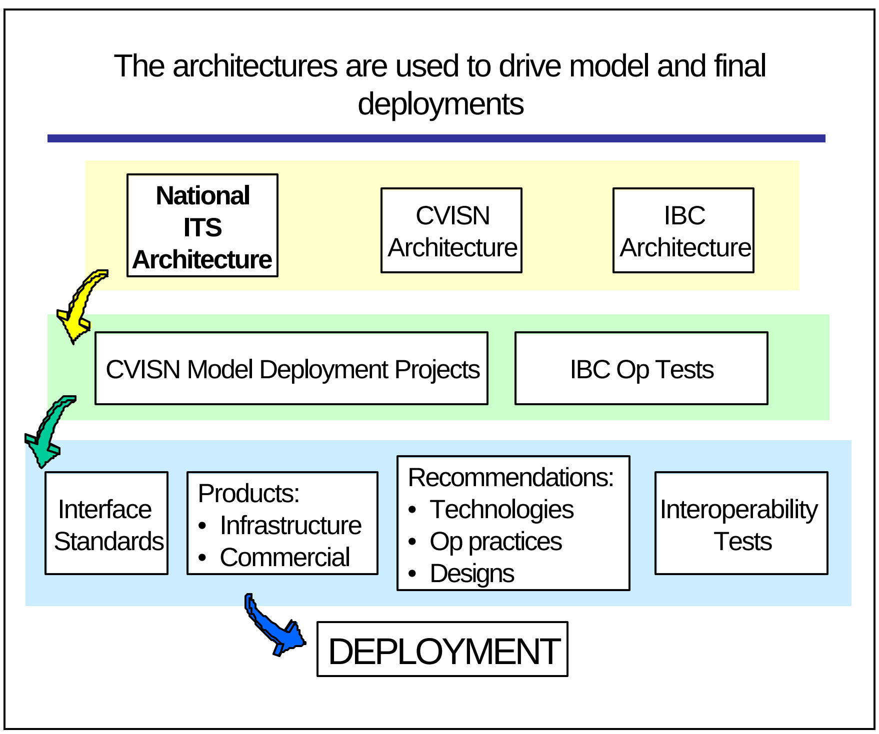

Figure 2-1. Architectures Drive Deployments

The top row shows the three architectures. The CVISN and IBC architectures were derived from the National ITS Architecture and go into more detail. That additional detail provided sufficient guidance to the CVISN model deployment projects and IBC operational tests for them to do detailed design. The projects produced interface standards, products, recommendations, and interoperability tests. Those efforts lead to deployment of systems that should be interoperable.

Figure 2-2 illustrates the incremental approach for CVISN deployment within a state. The state starts with the baseline from the architecture and model deployment phases. The first phase is devoted to developing the state top-level design and state CVISN Program Plan.

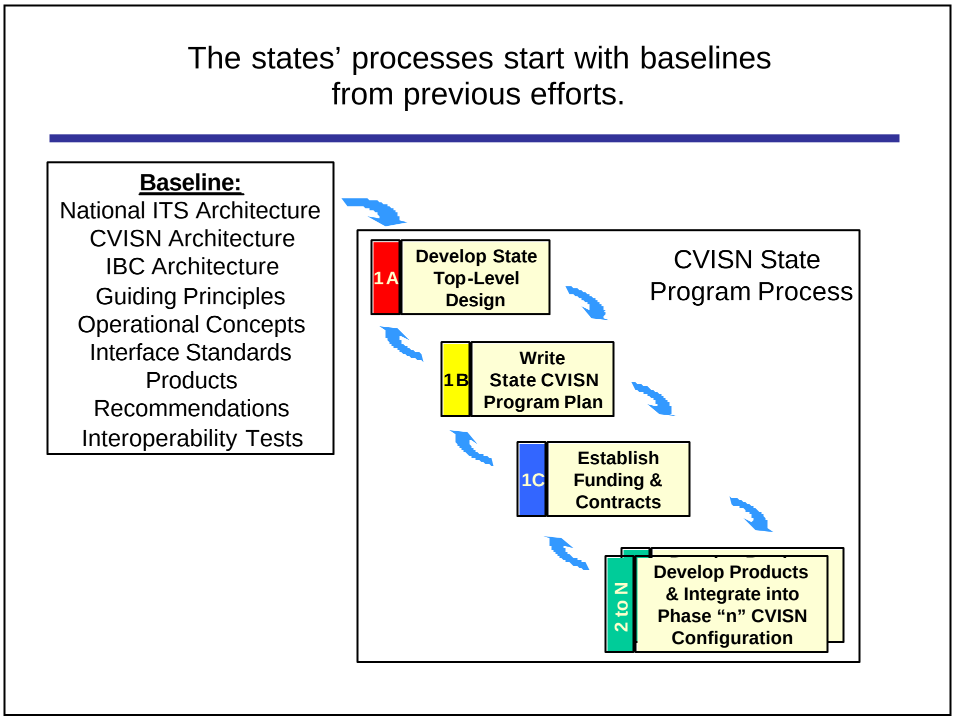

Figure 2-2. State CVISN Program Development

As stated in the Introduction, top-level design encompasses setting the scope of the program, defining top-level requirements, and laying out an initial high-level design for the state systems.

An overview of CVISN Level 1 requirements was defined in the *Introductory Guide to CVISN* (Reference 8). The *CVISN Operational and Architectural Compatibility Handbook (COACH)* Part 1 (Reference 2) provided additional details. Completing the COACH Part 1 tables helps the state set the scope of their CVISN program and define top-level requirements. Refined requirements and the initial top-level state design emerge from the process outlined in Chapter 5 of this document. The process is put into practice in the Scope Workshop.

The top-level design process will result in the definition of:

- User requirements
- System requirements
- Allocation of requirements to major system elements
- High-level interface specification

Review of the top-level design should involve the conformance assessment team (COAT), the program team, state information technology experts, and system users. The COAT should check that the design conforms with the CVISN architecture and standards. The program team should check that the design fulfills the program requirements. The state information technology (IT) experts should check that the design meets IT guidelines for the state and is consistent with related programs and projects. The users should verify that the design will improve their work environment and support operational requirements.

When the top-level design has reached a stage of reasonable maturity, a design baseline should be established. Changes to the baseline should be managed using a configuration management process. The configuration management process should be described in the CVISN Program Plan.

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3. CVISN OBJECTIVES, GUIDING PRINCIPLES, AND CONCEPTS

In this chapter, we gather from various sources the material that drives the CVISN Architecture. The Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) and CVISN objectives, guiding principles, and concepts have been stakeholder developed and stakeholder driven since 1991, with the first year of the Intermodal Surface Transportation Efficiency Act (ISTEA). These same general objectives, guiding principles, and concepts should also be strong influences on each state's top-level design.

3.1 CVISN Objectives Support the ITS/CVO Program Objectives

Objectives for ITS/CVO projects usually fall into the categories listed in the box at right. The CVISN objectives are intended to support those high-level CVO program objectives. Information system improvement should not be undertaken as technology for its own sake. Such improvement projects should show a clear benefit and connection to the ITS/CVO program objectives.

ITS/CVO Program Objectives

- Improve commercial vehicle safety
- Improve shipping efficiency
- Improve freight mobility
- Improve credentials & tax administration
- Ensure regulatory compliance & equitable treatment

Commercial Vehicle Information Systems and Networks (CVISN) Improvement Program Objectives

- Implement the CVO user services
- Improve CVO efficiency and effectiveness
- Promote consistency among processes and data
- Improve availability of timely, accurate information

Implement the CVO user services: The National Program Plan for ITS documents a carefully obtained consensus on what user services (e.g., automated roadside safety inspection, commercial vehicle administrative processes) are to be developed. These were considered as fundamental initial direction to the CVISN architecture program.

Improve CVO efficiency and effectiveness: Information technology is key to improvement of CVO processes. Many current bottlenecks can be alleviated with automation.

Promote consistency among processes and data: Inconsistent practices between jurisdictions or within a single jurisdiction make compliance for carriers more complex and expensive. Consistency reduces costs and improves productivity.

Improve availability of timely, accurate information: People make better decisions when they have better information. Likewise, automated processes are most effective when they operate with the most complete and accurate set of information available.

3.2 Guiding Principles for the CVISN Architecture

Statements of principle are being used to document fundamental concepts and guidelines supported by the CVO community. Guiding principles shaped the development of the CVISN Architecture. The principles should also be used to guide the state design process. The guiding principles were developed under the auspices of the ITS America CVO Program Subcommittee (Reference 12). The subcommittee, with representatives from most major CVO stakeholder groups, reached consensus about these principles after many hours of discussion. These principles continue to be reviewed periodically by ITS America and the US Department of Transportation. They will be updated as required to reflect the consensus of the CVO community. The current principles labeled "CVISN Architecture" are copied verbatim into this section.

1. The CVISN architecture will be **open**, modular, and adaptable.
2. The architecture will enable **data exchange** among systems, a key to reaching CVO objectives. Methods used to exchange data will ensure **data integrity and prevent unauthorized access**.
3. Data exchange will be achieved primarily via **common data definitions**, message formats, and communication protocols. These enable development of interoperable systems by independent parties.
4. A jurisdiction shall have and maintain **ownership of any** data collected by any agent on its behalf.
5. The architecture will accommodate **existing** and near-term **communications** technologies.
6. The architecture will accommodate **proven technologies and legacy systems** whenever possible.
7. The CVISN architecture will allow government and industry a **broad range of options**, open to competitive markets, in CVO technologies.

3.3 General Operational Concepts

General operational concepts were derived from concepts that apply to more than one of the CVISN capability areas (e.g., Safety Information Exchange, Credentials Administration, Electronic Screening). They were stated in the COACH Part 1 (Reference 2), and are repeated and further explained here. The operational concepts shaped the generic CVISN top-level design. The concepts should also be used to guide the state design process.

1. Good business processes can be enhanced through improved automated access to accurate information. Information sharing within a single jurisdiction and across jurisdictions using electronic networks is a cornerstone of the CVISN initiative. Information systems are only as good as the quality of the data they use. Data must be accurate, current, and safe from tampering or unauthorized disclosure.

2. Authoritative sources are responsible for maintaining accurate information. Each jurisdiction participating in ITS/CVO information exchange identifies the authoritative source for each data item. The term "authoritative source," also known as a system of record, is used to refer to that information system which can provide the correct answer to a

question. The authoritative source is the final arbiter in case of conflicts about data validity. It is the legal source of the data. Data that have been authenticated by the authoritative source have been proven to be genuine. In some cases, data are stored immediately and authenticated later by authorized personnel or systems.

3. Sometimes it is practical for authoritative systems to authorize indirect sources to assist in the information exchange process. An "indirect source" acts on behalf of an authoritative source to answer questions. Some authoritative sources may provide information to one or more indirect sources to facilitate giving answers to customers.

4. To enable cross-referencing and standard look-ups in multiple information systems, a common scheme for identifying carriers must be adopted. The Primary Carrier ID should be used in interface agreements (open standards, Internet-based exchanges, and custom interface agreements) to facilitate the exchange of carrier information. How the ID is stored internally outside the interface is up to the system implementers. The ID should be based on the USDOT number for both interstate and intrastate carriers. If it is not feasible for the state to use USDOT number as the ID type for all intrastate carriers, then the state should establish some convention for the Primary Carrier ID that will apply to all intrastate carriers in that state. [Please see Reference 16 for further details.]

   These are the segments for the Primary Carrier ID at the interface:
   a. ID Type
   b. If the ID was issued to an intrastate carrier, then there must also be a jurisdiction qualifier for the ID
   c. Carrier-Specific Identifier
   d. Carrier terminal ID designated by carrier

General Operational Concepts

1. Automated access to accurate information
2. Authoritative sources
3. Indirect sources

4 - 7. Standard identifiers

8. Snapshots
9. Flexible implementation/deployment options
10. Open standards
11. Resources focused on high risks
12. Interoperability through conformance checks & testing
13. Fair Information Principles
14. Citations issued after checking current status
15. Internet used for information exchange
16. WWW used for people and government information exchange
17. Focus on sharing data

5. To enable cross-referencing and standard look-ups in multiple information systems, a common scheme for identifying drivers must be adopted for interstate and intrastate

operators. The Commercial Drivers License (CDL) number should be the basis of the Driver ID. Please see Reference 16 for further details.

6. To enable cross-referencing and standard look-ups in multiple information systems, a common scheme for identifying vehicles must be adopted for interstate and intrastate operators. The Vehicle Identification Numbers (VIN) and jurisdiction plus license plate numbers should be the bases for the identification of power units. The Vehicle Plate ID consists of the country, subdivision (state or province), and license plate number. Please see Reference 16 for further details.

7. To enable cross-referencing and standard look-ups in multiple information systems, a common scheme for identifying international trips must be adopted. The Trip/Load number consisting of DUNS and trip-specific ID should be the basis for identifying international trips. Please see Reference 16 for further details.

8. Standard information exchange is supported via carrier and vehicle (and eventually driver) snapshots. ITS/CVO involves multiple applications and interfaces among hundreds of state agencies and thousands of carriers. Information exchange will be enabled through the use of standards. Many elements of CVO require information about the current and past safety performance and credentials status for carriers, vehicles, and drivers. Collecting the most-used information into standard messages will simplify systems since interfaces can be defined once, rather than negotiated between every pair of stakeholders. Carrier and vehicle snapshots containing safety and credentials data are part of CVISN Level 1.

9. Flexible implementation/deployment options are accommodated by the ITS/CVO architecture. As technology changes, so will the architecture. The architecture provides a common technical framework and a basis for developing interface standards. It does not specify a particular design for states or carriers; it allows them to select from a wide range of options to meet their particular needs. It only constrains design options in areas necessary to achieve interoperability and compatible practices. Before incorporating new technologies into the architecture, feasibility should be demonstrated. Several technology options and implementation choices are likely to continue to support the CVISN architecture's concepts and standards. Stakeholders choose the approach that best fits their business needs and available resources.

10. Open standards are used for interchanges between public and private computer systems. Open standards are those published in publicly available documents. Any vendor, developer, or private individual can create an application that uses an open standard. Today, ANSI ASC X12 EDI transactions are used for some carrier-state information systems' interactions. We anticipate that XML will be used in the future also. ANSI ASC X12 EDI transactions are also used for some state-core infrastructure information systems' interactions. Carriers in the United States have already embraced EDI for their fleet and business operations. Dedicated Short Range Communications (DSRC) standards for the messages, data link, and physical layers are used for vehicle-to-roadside interactions. DSRC standards apply not only to electronic screening, but also to toll, traffic, fleet applications, and border crossing processes throughout North America. The use of open DSRC standards for communicating between the vehicle and the roadside will allow a single transponder to be used for multiple applications throughout the states (and eventually North America). Additional openly-defined interfaces such as XML (eXtensible Markup Language) may also

be used to support CVISN functions, once feasibility and community support have been demonstrated. XML is intended to enable the use of SGML (Standard Generalized Markup Language, (ISO 8879), the international standard for defining descriptions of the structure and content of different types of electronic documents) on the World Wide Web.

11. Enhanced data exchange will allow all activities to focus resources on high-risk operators. The focus is possible because information access will enable roadside and deskside activities to identify the high-risk operators.

12. Interoperability is assured by a process of architecture conformance checks throughout a project's lifecycle, culminating in execution of standardized interoperability tests. If a tested system is changed, the interoperability tests are re-run as part of the re-validation process.

13. The Fair Information Principles for ITS/CVO (Reference 13) will be implemented using a combination of policies, procedures, technology, and training. Stakeholders will be included in the discussions of the techniques to be used to implement the principles.

14. Citations are based on a review of real-time conditions and checks with authoritative sources. To streamline operations and support preliminary quick checks, data will be provided from the infrastructure on a daily or more frequent basis. But whenever a final decision on citation or other action with legal implications is about to be taken, enforcement personnel should check with the authoritative source to verify the status of any related credentials.

15. The Internet is used as a wide area network for information exchange.

16. The World Wide Web is used for interactions and information exchanges between private people and government systems (e.g., for credentials applications or commercial vehicle regulations).

17. The focus is on sharing data among safety, credentialing and screening processes. The CVISN Program is structured to encourage states to design and deploy these three elements in parallel.

These high-level principles and concepts are used to drive top-level design decisions. Figure 3-1 illustrates the relationships among plans that outline changes in business processes and technical frameworks for implementing the plans. As shown in the figure, there is a flow-down from the national to the local business framework, and from national to local technical frameworks. Plans grounded in reality are more readily achievable than those developed without regard to whether or not technology supports the plan. Plans to improve processes must take into account the available technical tools. Systems deployed based on carefully considered plans are more likely to meet the needs of the users. **By building on the planning and technical efforts that have already been completed, new deployments can exploit the lessons learned and benefit from the collective brain trust.**

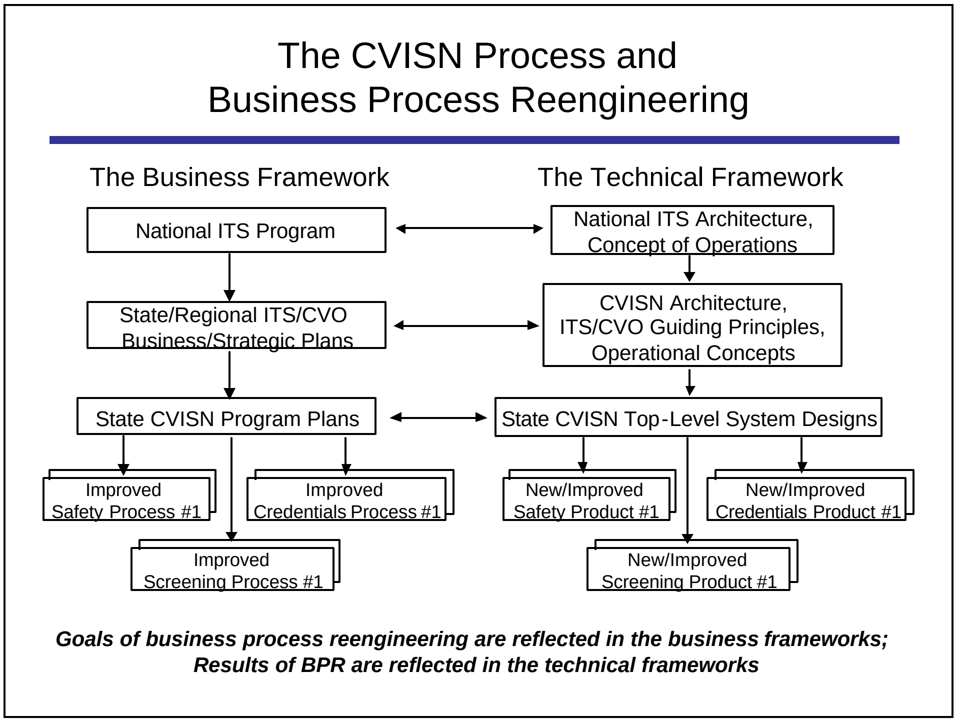

Figure 3-1. Technical Solutions Evolve from Clear Plans

4. CVISN TECHNOLOGIES

This chapter discusses some of the key technologies employed to support Safety Information Exchange, Credentials Administration, and Electronic Screening in the early CVISN implementations. The material is included to provide a brief introduction for those unfamiliar with the technologies. References are cited for those who need to know more.

The technologies discussed here are a subset of the full gamut of options available. The CVISN Guides for each functional area (References 9–11) give additional information.

4.1 Information Systems

An information system is an organized combination of people, hardware, software, procedures and other documentation, communications networks, and data resources that collects, transforms and disseminates information to meet some need. Information systems support both operations and management functions.

Broadly speaking, information systems include technologies that support input, processing, and output. That means that information systems include such technologies as computers (e.g., mainframes, personal computers, servers) and software (e.g., operating systems, graphical user interfaces, databases, database management systems, legacy systems, commercial off-the-shelf software). To make information systems work together, other technologies support them, such as networks (e.g., local area, wide area, Internet, wireless, wireline), and interface standards (e.g., EDI X12, XML, HTML, TCP/IP, SMTP).

For more information about information systems, please see References 27 and 29.

4.2 Networks

In information technology, a network is a series of points or nodes interconnected by communication paths. The most common topologies or general configurations of networks include the bus, star, and ring topologies. Networks can also be characterized in terms of spatial distance as local area networks (LANs) and wide area networks (WANs).

Internetworking is a term used by providers of network products and services as a comprehensive term for all the concepts, technologies, and generic devices that allow people and their computers to communicate across different kinds of networks. The common internetwork protocols, routing tables, and related network devices required to achieve this communication constitute internetworking.

State CVISN infrastructure components will be connected to each other by a LAN, WAN, or combination of both. As described in the next chapter, you will use the network template to illustrate your existing and planned connectivity.

Internetworking various CVISN aspects throughout North America involves many jurisdictions and many network types. When determining the network features for your own particular network, keep in mind what the final objectives of the network are and also what is currently in place in your state. If you are going to be connecting to other internal or external networks, provisions should be made to be compatible with those internal or external networks' technologies and protocols.

4.2.1 Some Common Terms Related To Networks

LAN – A local area network (LAN) is a small network of interconnected workstations and associated devices that share the resources of a single processor or server within a small geographic area (for example, within an office building). Usually, the server has applications and data storage that are shared in common by multiple workstation users. A local area network may serve as few as four or five users or many more.

WAN – A wide area network (WAN) is a geographically dispersed telecommunications network and the term distinguishes a broader telecommunication structure from a local area network (LAN). A wide area network may be privately owned or rented, but the term usually connotes the inclusion of public (shared user) networks.

Protocol – In information technology, a protocol is the special set of rules for communicating that the end points in a telecommunication connection use when they send signals back and forth. Protocols exist at several levels in a telecommunication connection. There are hardware telephone protocols. There are protocols between the end points in communicating programs within the same computer or at different locations. Both end points must recognize and observe the protocol. Protocols are often described in an industry or international standard.

Internet – The Internet is a world-wide network of computers, comprised of thousands of smaller regional networks scattered across the globe. It is now a public, cooperative, and self-sustaining facility accessible to tens of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol).

WWW – The World Wide Web (WWW) is the most widely used part of the Internet. Its outstanding feature is the Hypertext Transport Protocol (HTTP), a method of instant cross-referencing. In most Web sites, certain words or phrases appear in text of a different color than the rest; often this text is also underlined – clicking on these words/phrases transfers the user to relevant sites. The Web refers to a body of information – an abstract space of "pages" and links to pages accessible via the Internet, while the Internet refers to the physical side of the global network.

4.2.2 Network Implementation Is Guided By Existing Networks, Interfaces, and Standards

Existing networks within a jurisdiction will guide the future network connections and interfaces. As you implement CVISN, you will utilize networks that are already in place. Some new network technology may have to be integrated into existing technology within your state.

An *interface* is the physical and logical arrangement supporting the attachment of any device to a connector or to another device. New interfaces may be required to connect system elements to networks, or to connect network segments that were previously isolated from each other. Interface control documents (ICDs) are used to define how to connect to products like SAFER. Review the ICDs for the existing products with which your systems must exchange information early in the design phase to understand interface requirements that may impact your design.

Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose. By using standards for network components and interfaces, it is much easier to internetwork.

For more information about networks, please see References 45 through 48.

4.2.3 Why Was No One Particular Network Technology Chosen?

- There is no need to pick any one in particular. Internetworking is readily supported by the use of communications protocol standards.
- Stakeholders have already made networking investments that support their existing processes.
- CVISN Core Infrastructure systems have defined the sorts of interfaces they support. States that wish to connect to those systems must make design decisions accordingly. But those decisions can be limited to the interfaces, rather than necessarily applying across the entire state design.

4.3 Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) is the electronic exchange of business information in a standard format that permits *computer generation and processing* of the message. Using EDI reduces or eliminates paper transactions, and promotes *automated* processing and storing of data. In EDI, information is transmitted as text data files, and the information can be exchanged using almost any communications network and protocol.

For the CVISN program, "EDI" refers to the use of nationally recognized open standards for data exchange between trading partners. The process requires a commercially available EDI translator, or interface, to the trading partner's legacy system database that will create the standard message format for the exchange of information. The EDI standard format eliminates the need for a variety of proprietary data exchange formats among numerous entities.

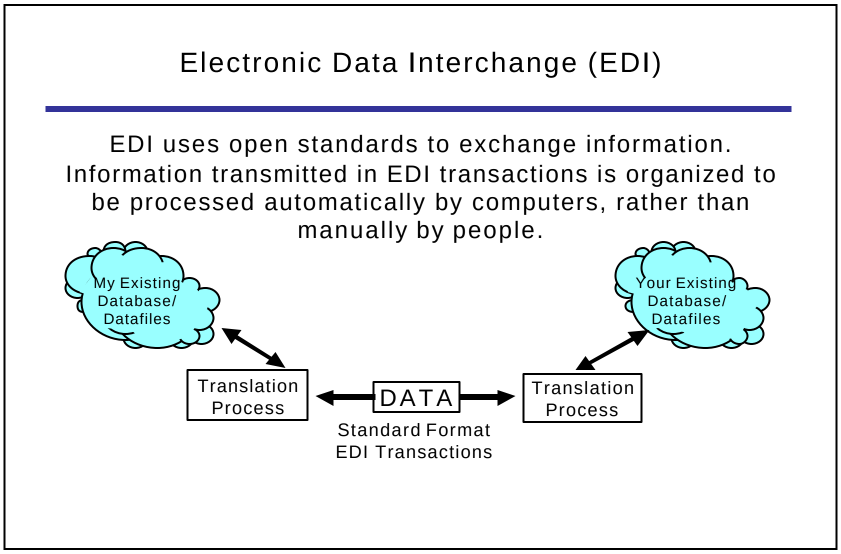

Figure 4-1. EDI Illustration

4.3.1 Some Common Terms Used In EDI

Transaction Set – A meaningful unit of information exchanged between trading partners. A transaction set corresponds to a business document or form and defines that business information in a standard syntax. It consists of a header segment, one or more data segments in a specified order, and a trailer segment. The scope and purpose of the transaction set are specific to the business needs in the data exchange.

Map (noun) – A definition of the relationship between application data and the X12 standard segments and elements.

Mapping (verb) – The process of converting data from one format to another according to the "map" (noun). Generally, a piece of software called an EDI translator is invoked.

4.3.2 EDI Implementation Is Guided By Standards, Guidelines, and Agreements

EDI Standards for transaction sets (TS) are the technical documents approved by American National Standards Institute (ANSI) Accredited Standards Committee (ASC) X12 that define the structure and meaning of data passed between trading partners (Reference 17). The EDI standards used in CVISN applications are identified in the COACH Part 4, Interface Specification Checklists (Reference 5).

Guidelines for EDI implementation are divided into two types. For many applications, the application-specific EDI Implementation Guides (IGs) are all that is needed. For some applications, interface control documents that tailor the standard EDI IGs with jurisdiction-specific constraints/differences are also required.

The application-specific EDI Implementation Guides provide instructions and reference information on the use of an EDI transaction set to satisfy specific business needs, and contain both business and technical information. For example, for transaction set 286 (Commercial Vehicle Credentials), there is one IG for each type of credential, such as the EDI IG for TS 286 IRP Credential Transactions. An application-specific implementation guide is intended to:

- Provide guidance and reference information for public and private agencies to implement and maintain connections using the transaction set for a particular related set of functions.
- Provide specific coding information for implementing the transactions between trading partners.

The scope of each application-specific implementation guide can be described as follows. It:

- Presents the business case: envisioned environment for the transaction set; information concerning timing of transactions; security; acknowledgements; and legal considerations.
- Presents details of the transaction set: control segments; segment usage; and transaction examples based on the ANSI ASC X12 syntax for various message types (e.g., IRP Supplemental).

References 18–22 are the implementation guides prepared so far for CVISN. State designers should be sure to refer to the business processes described in the IGs, and make sure that their software vendors and EDI developers utilize the guidelines in these documents.

Individual jurisdictions sometimes have particular business rules that further specify how the standard and conventions should be used. Individual jurisdictions and systems may also have particular acknowledgment and error-handling requirements that are not covered by the flow sequences shown in the application-specific IGs. A jurisdiction usually offers only selected telecommunications and network connection options. In that case, the jurisdiction should develop one or more *Jurisdiction-Specific EDI Interface Control Documents (ICDs)*. It is practical to develop an EDI ICD for a particular functional area, for example, electronic credentialing. The degree of formality for an EDI ICD depends on the number of contractors involved; more contractors implies more formality. In CVISN implementations thus far, an EDI ICD has been strongly recommended only for electronic credentialing.

Research into data requirements, application processes, and database design is a necessary part of the EDI implementation process. The jurisdiction-specific constraints/differences that have been identified in the CVISN Model Deployment effort are listed below. The list is intended as a reminder for the EDI developer. Getting a clear picture of these constraints and differences are central to the research process for a jurisdiction. If these topics are researched adequately, the developed EDI package should meet the jurisdiction's and applicant's business needs.

- Policies
- Application procedures
- Validation procedures
- Acknowledgment protocols
- Error-handling protocols

- Credentials issued (temporary, permanent, etc.)
- Electronic payment options
- Data element requirements (optional, mandatory)
- Data element attributes (length, type, valid codes, etc.)

The state can tailor the application-specific EDI IGs by making more specific the general guidance provided in the IGs. It is not appropriate for a state to use a different data segment or data element than those specified in the IGs.

Trading Partner Agreements ensure compliance with national standards for computer security and privacy, and legally bind the trading partners to the terms, conditions and regulations included in the agreement.

A common implementation choice is to couple existing systems to an EDI translator software package and a commercial network.

For more information about EDI, please see References 30-33 and similar titles.

4.3.3 Why Was EDI Chosen?

- Carriers use ANSI ASC X12 EDI for various business functions.
- Carriers believed EDI must be a component of any electronic credentialing system.
- EDI was chosen as the initial open standard over UN/EDIFACT because most American carriers do not now use UN/EDIFACT standards and have no intention to do so.
- EDI was chosen over the emerging eXtensible Markup Language (XML) because of its maturity. Tests of XML for some CVISN functions are now occurring. If XML proves to be a viable alternative, and the CVO community endorses it, it will be added as another CVISN technology option.

4.4 Extensible Markup Language (XML)

Extensible Markup Language (XML) is a set of rules/guidelines/conventions used to design text formats for structured data. Using XML as an alternative to (though not necessarily a replacement for) EDI for computer-to-computer exchange is a likely possibility that is actively being explored. XML is a “metalanguage” that allows a group of stakeholders and organizations to create their own markup languages for exchanging standardized information in a consistent way. “XML files are easy to generate and read (by a computer), are unambiguous, and avoid such common pitfalls as: lack of extensibility, lack of support for internationalization and localization, and platform-dependency.” (Reference 58) XML provides a flexible way to create common information formats and share both the format and the data on the WWW, intranets, and elsewhere.

4.4.1 XML Terms and Specifications

Several terms commonly used in discussions of XML are explained below.

Markup - markup refers to the sequence of characters or other symbols that you insert at certain places in a text or word processing file 1) to indicate how the file should look when it is printed or displayed or 2) to describe the document's logical structure.
Tags – entity and element delimiters; each component must have a start-tag and an end-tag.

Well-formed – a well-formed XML document is one in which the tags are properly constructed, every start-tag has an associated end-tag, and the elements they identify are nested properly, one within the other. An XML parser ensures that an XML document is well-formed.

Document Type Definition (DTD) – a formal model that defines the role of each element of text. The DTD declares each of the permitted entities, elements and attributes, and the relationships between them. (Reference 51)

Valid – a valid XML file is well-formed and has a DTD to which it adheres.

Standard Generalized Markup Language (SGML) – SGML is an international standard (ISO 8879) for defining descriptions of the structure and content of different types of electronic documents. XML is a simplified subset of SGML facilities designed to enable the use of SGML on the World Wide Web.

Style Sheet – style sheets describe how documents are presented on screens, in print, or perhaps how they are pronounced.

Cascading Style Sheets (CSS) – "CSS is a simple styling language which allows attaching style to HTML elements. Every element type as well as every occurrence of a specific element within that type can be declared an unique style." (Reference 59)

XML Specifications

XML is a project of the World Wide Web Consortium (W3C); the development of the XML specification is being supervised by their XML Working Group. XML is a public format, not a proprietary development of any company. Specifications developed within W3C must be formally approved by the Membership. Consensus is reached after a specification has proceeded through the review stages of Working Draft, Proposed Recommendation, and Recommendation. The W3C publishes recommendations that have been endorsed by its Director and reviewed by W3C members, other interested parties and the W3C Advisory Committee. W3C's role in making the recommendations is to draw attention to the specifications and to promote their widespread deployment, thus enhancing the functionality and interoperability of the Web. The W3C has several activity groups that continue to work on different aspects of XML. The latest status of the W3C can be found at its Web site. (Reference 52)

W3C specifications may go through several stages. They are, from lowest to highest: Note, Working Draft, Candidate Recommendation, Proposed Recommendation and Recommendation. The following is taken from Reference 52.

- "A Note is a dated, public record of an idea, comment, or document. A Note does not represent commitment by W3C to pursue work related to the Note.
- A Working Draft represents work in progress and a commitment by W3C to pursue work in this area. A Working Draft does not imply consensus by a group or W3C.
- A Candidate Recommendation is work that has received significant review from its immediate technical community. It is an explicit call to those outside of the related Working Groups or the W3C itself for implementation and technical feedback.
- A Proposed Recommendation is work that (1) represents consensus within the group that produced it and (2) has been proposed by the Director to the Advisory Committee for review.
- A Recommendation is work that represents consensus within W3C and has the Director's stamp of approval. W3C considers that the ideas or technology specified by a Recommendation are appropriate for widespread deployment and promote W3C's mission."

What follows are brief descriptions of some of the XML-related specifications. The latest specification for each is available at the given URL. The status given for each specification (link) is as of the publication date of this document.

Extensible Markup Language (XML)

> "Extensible Markup Language (XML) is a subset of SGML. ... Its goal is to enable generic SGML to be served, received, and processed on the Web in the way that is now possible with HTML. XML has been designed for ease of implementation and for interoperability with both SGML and HTML." (W3C Recommendation) (Reference 52, http://www.w3.org/TR/REC-xml)

Namespaces

> "XML namespaces provide a simple method for qualifying element and attribute names used in Extensible Markup Language documents by associating them with namespaces identified by URI references." (W3C Recommendation) (Reference 52, http://www.w3.org/TR/REC-xml-names)

Document Object Model (DOM)

> The DOM is "a platform- and language-neutral interface that allows programs and scripts to dynamically access and update the content, structure and style of documents. The Document Object Model provides a standard set of objects for representing HTML and XML documents, a standard model of how these objects can be combined, and a standard interface for accessing and manipulating them. Vendors can support the DOM as an interface to their proprietary data structures and Applications, and content authors can write to the standard DOM interfaces rather than product-specific Application Processing Interfaces, thus increasing interoperability on the Web." (W3C Recommendation)

(Reference 52, http://www.w3.org/TR/REC-DOM-Level-1 and http://www.w3.org/TR/DOM-Level-2-Core)

Resource Description Framework (RDF)

"RDF is a foundation for processing metadata; it provides interoperability between applications that exchange machine-understandable information on the Web. RDF emphasizes facilities to enable automated processing of Web resources… The RDF integrates a variety of web-based metadata activities including sitemaps, content ratings, stream channel definitions, search engine data collection (web crawling), digital library collections, and distributed authoring, using XML as an interchange syntax." (W3C Recommendation, Candidate Recommendation) (Reference 52, http://www.w3.org/TR/REC-rdf-syntax and http://www.w3.org/TR/rdf-schema)

Extensible HyperText Markup Language (XHTML)

"XHTML is a family of current and future document types and modules that reproduce, subset, and extend HTML 4. XHTML family document types are XML based, and ultimately are designed to work in conjunction with XML-based user agents." (W3C Recommendation) (Reference 52, http://www.w3.org/TR/xhtml1)

XML Schema

"XML Schemas express shared vocabularies and allow machines to carry out rules made by people. They provide a means for defining the structure, content and semantics of XML documents. The purpose of a schema is to define and describe a class of XML documents by using these constructs to constrain and document the meaning, usage and relationships of their constituent parts: datatypes, elements and their content, attributes and their values, entities and their contents and notations. Schema constructs may also provide for the specification of implicit information such as default values. Schemas document their own meaning, usage, and function. Thus, the XML schema language can be used to define, describe and catalogue XML vocabularies for classes of XML documents." (W3C Candidate Recommendation, Note) (Reference 52, http://www.w3.org/TR/xmlschema-0/ and http://www.w3.org/TR/NOTE-xml-schema-req)

Extensible Stylesheet Language (XSL)

"XSL is a language for expressing stylesheets. It consists of two parts:

- XSL Transformations (XSLT): a language for transforming XML documents
- An XML vocabulary for specifying formatting semantics (XSL Formatting Objects)

An XSL stylesheet specifies the presentation of a class of XML documents by describing how an instance of the class is transformed into an XML document that uses the formatting vocabulary." (W3C Candidate Recommendation) (Reference 52, http://www.w3.org/TR/xsl/)

Additional W3C specifications relevant to XML include: XML Query, XPath, XPointer, XML Base, XLink, XML Signature and Canonicalization. The complete specifications for these can be accessed via the W3C XML link http://www.w3.org/TR/REC-xml.

The following figure (Figure 4-2) is taken from Reference 55.

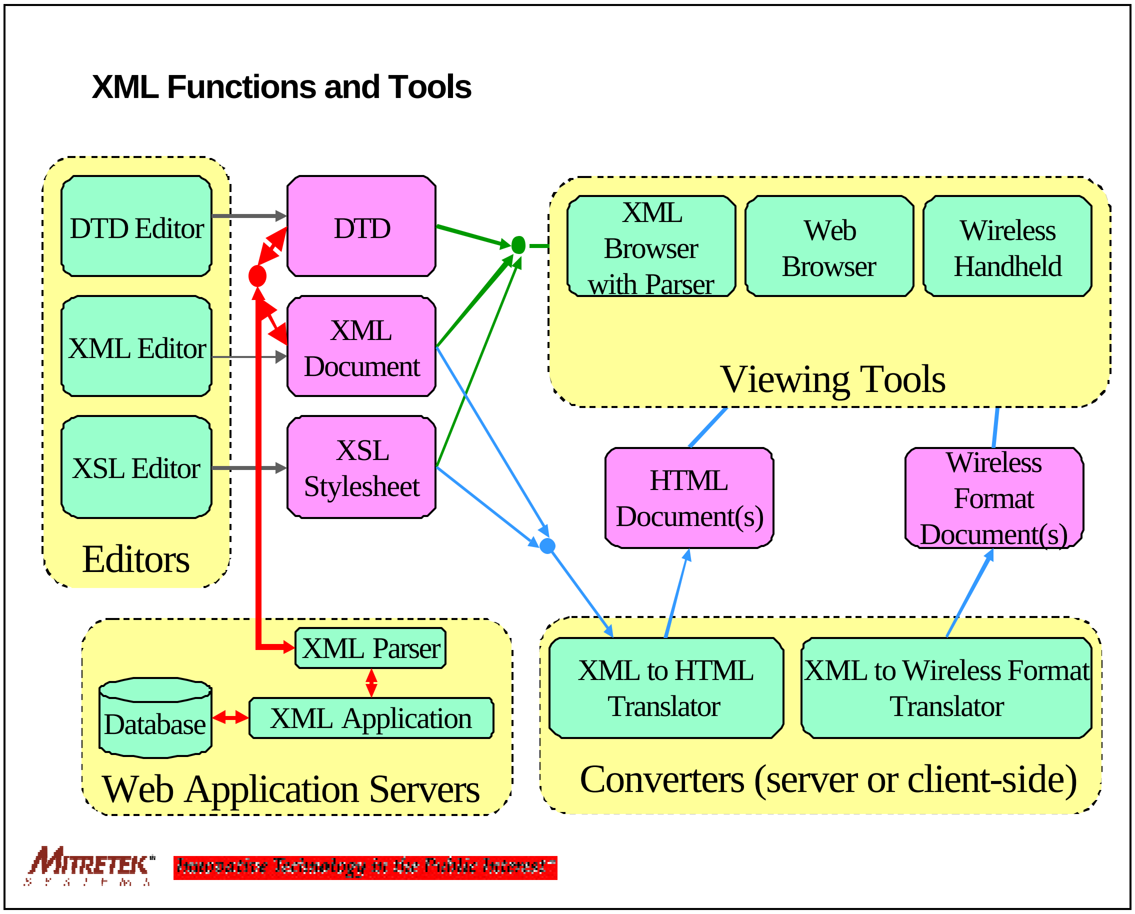

Figure 4-2. XML Illustration

4.4.2 XML and CVISN

It is expected that XML can provide the means for data transfer among: agencies within states, one state and other states, governmental agencies and the private sector, governmental agencies and citizens, and Internet Service Providers and customers. In the CVISN arena, XML might be used:

- To supplement or replace HTML or dynamic HTML in support of Web sites where information is collected by a government agency from a person using a commercial browser (e.g., to renew a single credential) or provided by a government agency to a person using a commercial browser (e.g., to view a single snapshot),
- As an alternative to EDI for defining file formats for computer-to-computer information exchange (e.g., for credential renewals for a fleet or to fulfill a snapshot subscription), and
- As an alternative for computer-to-computer snapshot (input and output) interfaces with SAFER. (Reference 55)

Information exchange and analysis will be facilitated if participants use a common XML CVO vocabulary because:

- XML provides excellent capabilities for data manipulation,
- XML provides for one time definition and reusability of a common XML CVO vocabulary,
- CVO-specific XML DTDs/schemas can be made available via the Web in a controlled repository, and
- XML is applicable to Web sites as well as to computer-to-computer interfaces.

Why is XML being considered?

- XML is license-free, platform-independent, application-independent and well-supported.
- Free or low-cost tools are available to support XML development and use.
- Using XML for CVISN is not likely to require modifications to the XML specifications.
- XML is intended to keep the key SGML advantages of extensibility, structure and validation in a language that is designed to be vastly easier to learn, use and implement than SGML.
- "Information providers can define new tag and attribute names at will." (Reference 56)
- "Document structures can be nested to any level of complexity." (Reference 56)
- "The ability to capture and transmit semantic and structural data made possible by XML greatly expands the range of possibilities for client-side manipulation of the way data appears to the user. " (Reference 56)

For more information about XML, please see References 50-63 and similar titles. Work on developing a common XML CVO vocabulary is underway.

Using XML to accomplish CVISN computer-to-computer or person-to-computer information exchanges will not be significantly simpler than using EDI or HTML for the same exchanges, but the technology may be cheaper to implement because some rudimentary tools are available for free or at low cost.

4.5 Dedicated Short-Range Communications (DSRC)

DSRC provides data communications between roadside equipment and a specific moving vehicle by means of a radio frequency transponder located in the cab of the vehicle. The transponder may contain identifiers and possibly additional data. DSRC can support electronic screening, electronic tolls, fleet management, and other roadside communications. Hardware and communications standards have been developed and are under development by the American Society for Testing and Materials (ASTM) (Please see References 23 and 49). The Institute of Electrical and Electronics Engineers (IEEE) is establishing message set standards (IEEE Standard 1455-99; please see Reference 25).

4.5.1 Some Common Terms Related To DSRC

These terms are a subset of those defined in IEEE Standard 1455-99 (Reference 25).

Transponder (or "tag") – The on-board component of a DSRC system.

Beacon – A roadside system at which DSRC can be accomplished. A beacon typically consists of a reader and an antenna.

Reader – A component of the roadside beacon that provides the capabilities for radio wave communications with a transponder.

Antenna – A device used to send or receive radio waves.

Message – A package of information meeting a standard format that is sent to or from a transponder's memory.

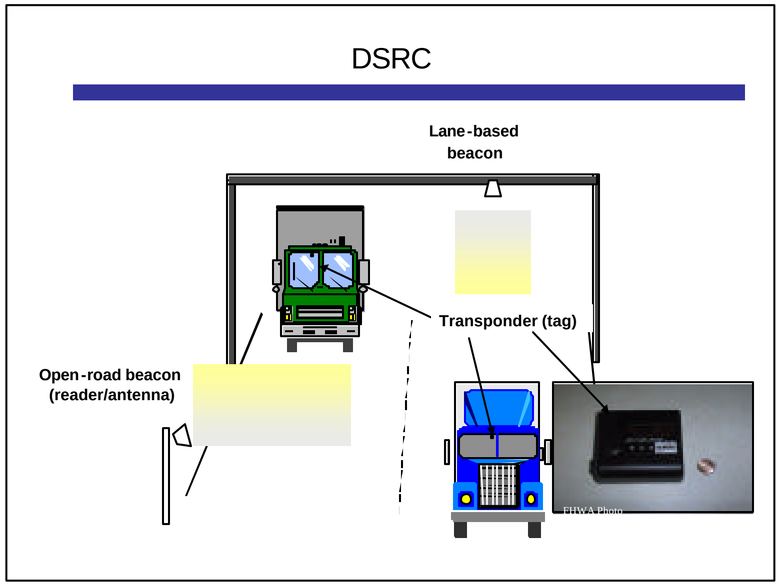

Figure 4-3. DSRC Illustration

4.5.2 DSRC Implementation Is Guided By Standards and Guidelines

There are three *standards* that are required to implement DSRC.

1. The Application Layer standard has been developed as IEEE Standard 1455-99. This standard deals with how all the data are organized for all the applications of DSRC, CVO, tolls, etc., and how this data is accessed for transmission over the radio link. (This is referred to as Level 7 of the Open Systems Interconnection (OSI) model for standards.)

2. The Data Link Layer specification is based on the existing DSRC products used for CVO and is designated as ASTM v6. This specification determines the protocol for actual transmission and reception of the information over the radio link. (This is referred to as Level 2 in the OSI model for standards.)

3. The Physical Layer standard was developed as ASTM PS 111-98. This standard deals principally with the radio frequency characteristics of the link including the use of active or backscatter technology. (This is referred to as Level 1 in the OSI model for standards)

These three documents are the basis of the Sandwich Specification protocol, which has been proposed by FHWA, for use in future federally-funded CVO deployments. This Sandwich protocol is backwards compatible with existing DSRC hardware used in E-Screening. By implementing IEEE Standard 1455-1999, this protocol also supports multiple applications using the same DSRC transponders.

Under the Transportation Equity Act for the 21st Century (TEA 21), the Congress has given the United States Department of Transportation (US DOT) the responsibility to "ensure national interoperability" of ITS technologies through the development and promulgation of standards. Further, the Congress authorized the Secretary of the US DOT to issue "provisional standards" when the normal consensus standard development process was unsuccessful in reaching agreement on a standard. To implement the requirements of TEA 21, and address the current applications of DSRC technology, the US Department of Transportation has three major objectives:

- To achieve national interoperability for the CVISN and Border Crossing functions currently being deployed
- To promote standardization in the other applications of DSRC technology, including electronic toll collection, to the degree it is feasible
- To promote the use of ITS standards for all ITS projects.

According to the Notice of Proposed Rulemaking for DSRC in ITS/CVO (Reference 26), to achieve the US DOT's objectives, the following approach has been selected. The DSRC provisional standard is defined in the FHWA specification (Reference 24).

1. For the immediate future, all CVO and Border Crossing projects will continue to utilize the current DSRC configuration employed by the programs. This is the "ASTM version 6" active tag.
2. Beginning January 1, 2001, all CVO and Border Crossing projects will use a provisional standard as described below. In addition, this provisional standard will be designed to ensure interoperability with the existing legacy equipment used in CVO that conforms to ASTM Version 6. *The provisional standard consists of the following "sandwich" protocol:*
   A. the new ASTM Physical Layer in the active mode,
   B. the existing ASTM Version 6 Data Link layer in the synchronous model,
   C. and the IEEE Standard 1455-99 Application layer.

To help implementers understand the implications of this policy, *a DSRC Implementation Guide for CVO Deployments* will be prepared. The DSRC IG is intended to provide specific guidance on DSRC issues not fully addressed by the ASTM standards and IEEE Standard 1455-99. These issues may include such topics as frequency band selection, protocol mode, message selection, resource manager design, resource manager to back-office application interface, DSRC interference and security. The content of this guide will be based on lessons learned, product testing and technical discussions with DSRC vendors.

Table 4-1 shows how the currently available transponders map to the standards. Only the Type IIIm transponders support applications where messages are required.

Table 4-1. Transponders - Standards Relationships

Transponder Type	ASTM Physical Layer	ASTM Data Link Layer	IEEE Standard 1455-99 Message
Type II	Version 6	Version 6	n/a
Type III	Version 6	Version 6	n/a
Type IIIm	Version 6	Version 6	Limited subset of messages only

For more information about DSRC, please see References 23–26 and 49.

4.6 Sensors

Sensor technology can identify potential safety or compliance problems. Sensors can be used to detect potential overweight vehicles, detect possible braking or balance hazards, detect hazardous conditions for prompt treatment, and observe traffic flow for traffic management.

Sensor technology can also be used to automatically classify vehicles using axle detectors, inductance loops, and weigh in motion. Weigh in motion can also be used to measure axle weights for balance and weight distribution (balance and braking safety), axle and gross weights for bridge safety restrictions, weight detection for screening to enhance the efficiency of enforcement, and axle and gross weight data collection to assess road wear and tear for highway planning.

For more information about sensors, please see Reference 29.

5. TOP-LEVEL DESIGN PROCESSES

A top-level design is one of the outcomes of analyzing your state's existing systems, CVISN project objectives, guiding principles, existing and planned business processes, and intended operational changes. Typically, by the time a top-level design is completed, you should have captured these components:

- User requirements
- System requirements
- Allocation of requirements to major system elements
- High-level interface specification

Starting before the CVISN Scope Workshop, states are encouraged to use a particular process for starting with the CVISN Architecture and tailoring it to produce a top-level design. The process is based on defining operational scenarios that improve business processes. States overlay their business processes with the objectives, operational concepts, and requirements for the use of open standards specified in the CVISN Architecture. The results reflect a re-engineering of the business processes that improve the existing system.

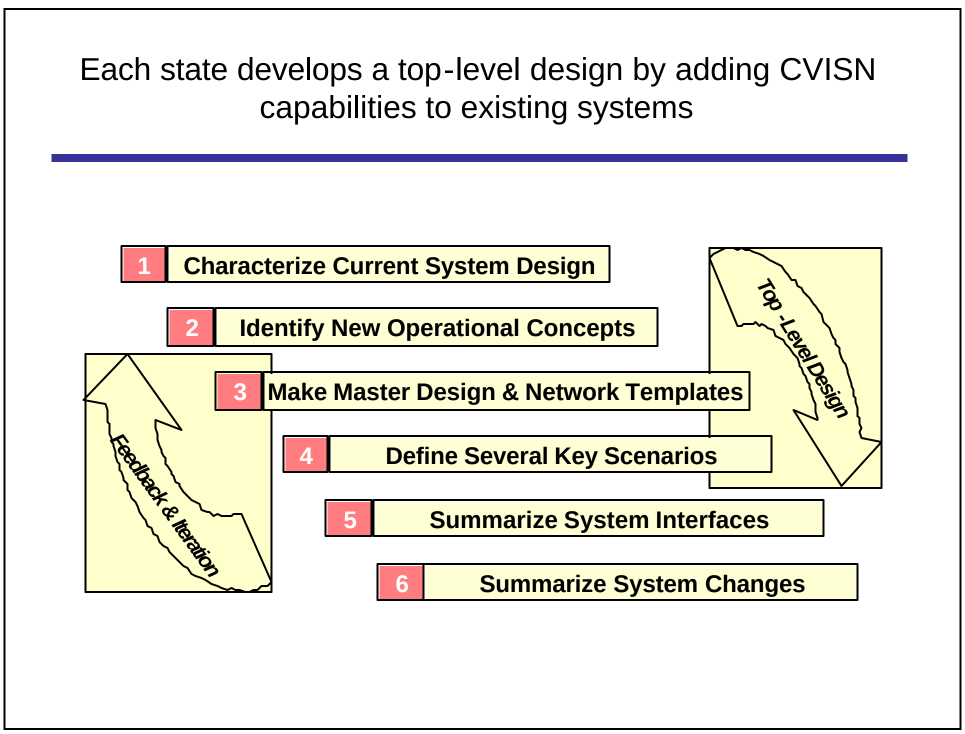

Figure 5-1. Top-Level Design Steps

Even though the steps are shown as sequential, the process actually involves a great deal of feedback and iteration. Throughout the process, participants should identify issues, actions and decisions. Each state will publish the final results as a State CVISN Design Description. Appendix B presents a candidate format for such a document.

The process of defining operational scenarios involves thinking about what you do today, and how you want to improve those processes. In this you are either reflecting the results of your completed business process reengineering, or are accomplishing that reengineering. Typically, the steps in business process reengineering include:

- The organization asks itself:
  - What do we do
  - Why do we do what we do
  - Why do we do it the way we do
- The organization determines how to improve the basic business processes
- The organization evaluates how technologies can be applied to help

The goal of reengineering is to improve the existing processes. The improvement may be targeted towards such goals as reducing manual tasks, focusing resources on problem areas, simplifying information flow, reducing transaction cycle time, improving system response time, improving the quality of information generated and received, removing distance as a barrier to interaction, and others. Building on the reengineering efforts that have already been accomplished in the CVISN Model Deployment states, new states can benefit from lessons learned.

Before attending the Scope workshop, states should attempt to complete steps 1 through 3 shown in Figure 5-1. There will be time in the workshop to refine the initial drafts, but the workshop process will be more valuable if preliminary versions of the state's templates are completed as part of the pre-work.

The remainder of this chapter explains the process.

5.1 Characterize Current System Design (Step 1)

In this step, you characterize your current system design. Chances are that the CVISN project will involve some modifications to existing (legacy) systems. Before you make decisions about what and how to change anything, it is a good idea to be clear about how the existing systems work.

Inventory each system that you imagine will be involved in CVISN Level 1 capabilities (see the Introductory Guide to CVISN, Reference 8 for a reminder). By "inventory" we mean collect information to help you understand what the system already does, who is responsible for it, what it connects to, and how easy/hard it will be to modify it. The pre-work for the Scope Workshop contains an inventory form that should be useful. If you already have the inventory information summarized in some other format, it is not necessary to transpose it onto the workshop pre-work forms.

The systems about which information should be collected include at least the products that handle IRP, IFTA Registration, IFTA Tax Processing, Roadside Operations, Inspections, and other safety systems that connect to MCMIS.

It may also be useful to illustrate the current design using the system design template style explained in step 3. You can illustrate which functions exchange information today by drawing lines to connect the boxes. You will also illustrate some of the inventory information on the network and computer template in step 3 (section 5.3).

5.2 Identify New Operational Concepts (Step 2)

Before beginning this step, we recommend that you brainstorm the top-level objectives for your CVISN project. Review your ITS/CVO Business Plan. Review the definition of CVISN Level 1. Involve all members of the project team and motor carrier representatives, and construct a list of your project's objectives. If the list doesn't include all the CVISN Level 1 capabilities, note a brief explanation.

In this step, identify where your current and planned operational concepts and design are and are not compatible with CVISN. In this step, you begin to make choices about what you are and are not going to do in your CVISN project. If you have already evaluated your existing business processes and made choices about re-engineering them, this step should be fairly straightforward. If not, this step will help you start that process.

The tool for this step is the COACH Part 1. By completing the "Commit Level" column in the tables in the COACH Part 1, you will face the operational concepts and top-level design guidelines for CVISN. Pay special attention to the items in the COACH Part 1, Chapter 2, Guiding Principles, and the items in subsequent chapters that are associated with CVISN Level 1. Disagreeing with those items may indicate a fundamental disagreement with CVISN concepts.

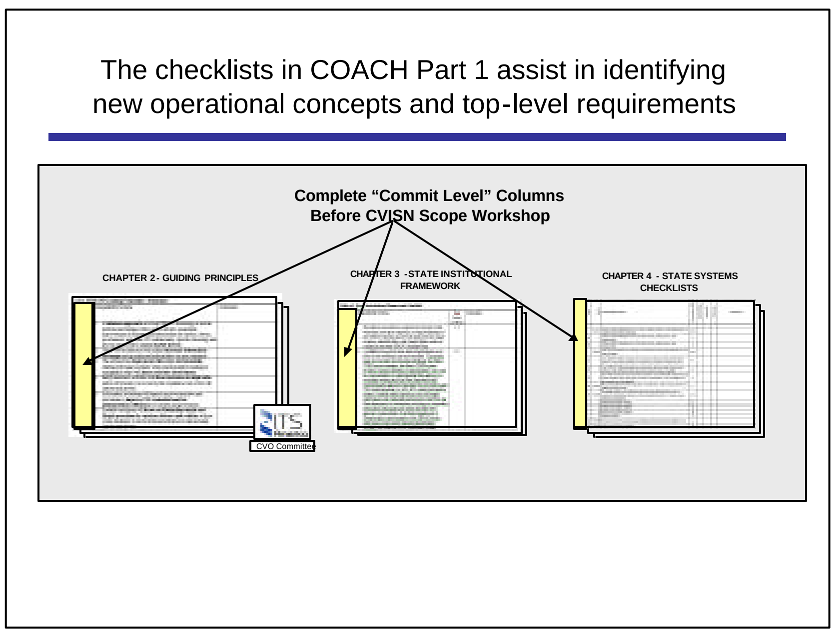

Figure 5-2. COACH Part 1

If you have a serious disagreement with CVISN concepts, then consult your FMCSA Division Office or Service Center.

The entire CVISN project team should be involved in this step. Different functional areas may have different reactions to some of the operational concepts and top-level design guidance. During the process, the team should air those differences, and work towards some sort of consensus.

The combination of your project objectives and the completed COACH Part 1 tables form an initial set of requirements for the project.

5.3 Make Master Templates (Step 3)

In this step, you make two templates: a master state system design template, and a network template. These templates reflect your initial top-level design decisions. The templates show the major functions, how those functions are allocated to computers, and what network connectivity is envisioned to support system interactions. As you use the templates in the succeeding steps, you will probably change them. It's a good idea to keep one master copy of each template, so that you don't lose any revisions. Early on, assign an "owner" for each template, the person who will be responsible for maintaining the master. You might want to do a "current systems" view and a "proposed systems" view of each template, to show what you are planning to add.

5.3.1 State System Design Template

The state system design template will be used to illustrate operational scenarios. This diagram is the one that the CVISN Model Deployment states found most useful for team communications. Everyone can see his or her own functional area on this diagram. The template can be used in many different ways, as you learned in the Understanding ITS/CVO Technology Applications course (Reference 29). In the Scope workshop, you'll use this template for illustrating both operational scenarios and system interfaces.

Include all the major functions in your state that support CVO. There should be exactly one box representing each major function. Start by reviewing the generic template (Figure 5-3), and then tailor it to your state. Recall your project objectives and the answers you gave when completing the COACH Part 1 tables. Remove functions that don't relate to your CVISN project. Add a box for each major function that is missing.

The generic state system design template reflects the generic CVISN state design. The CVISN System Design Description (Reference 7) explains more about the generic design. The small LSI and LM boxes on the generic state system design template refer to Legacy System Interfaces and Legacy Modifications. The state chooses whether to modify the legacy system (LM - legacy modification) to support EDI (and other new functions and interfaces), or to create a Legacy System Interface (LSI) to deal with the EDI-to-native form interface. Many CVISN Model Deployment states are implementing a mix of LSIs and LMs.

In this template, it is not important to group the functions that are handled within the same computer, nor to show how systems are connected through networks. Those aspects of design will be illustrated on the second template.

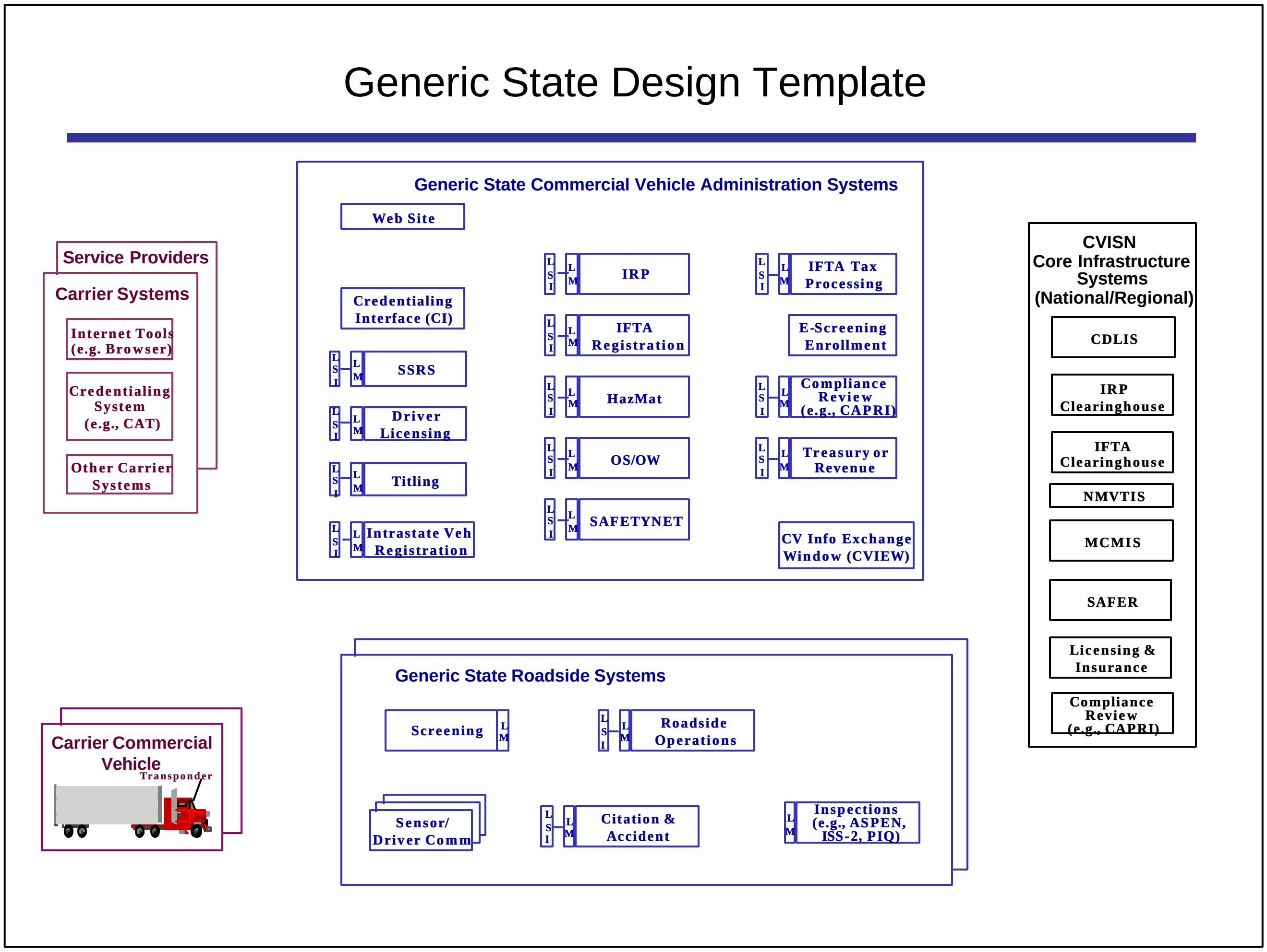

Figure 5-3. Generic State System Design Template

5.3.2 Network Template

The network template shows how your state allocates the major functions to computers, and how those computers are connected using various kinds of network technologies.

To make your master network template, review the generic network template (Figure 5-4). Tailor the generic network template to your state. Start by including all the computers and networks that support the systems you included in your current systems inventory. Next, be sure that the existing major functions on your system design template are allocated to some computer on the network and design template. As necessary, add computers and network components. If you don't know what kind of computer or what networking technology you'll use, put in a placeholder and note it as an open issue. The drawing will mature as you work through the design process.

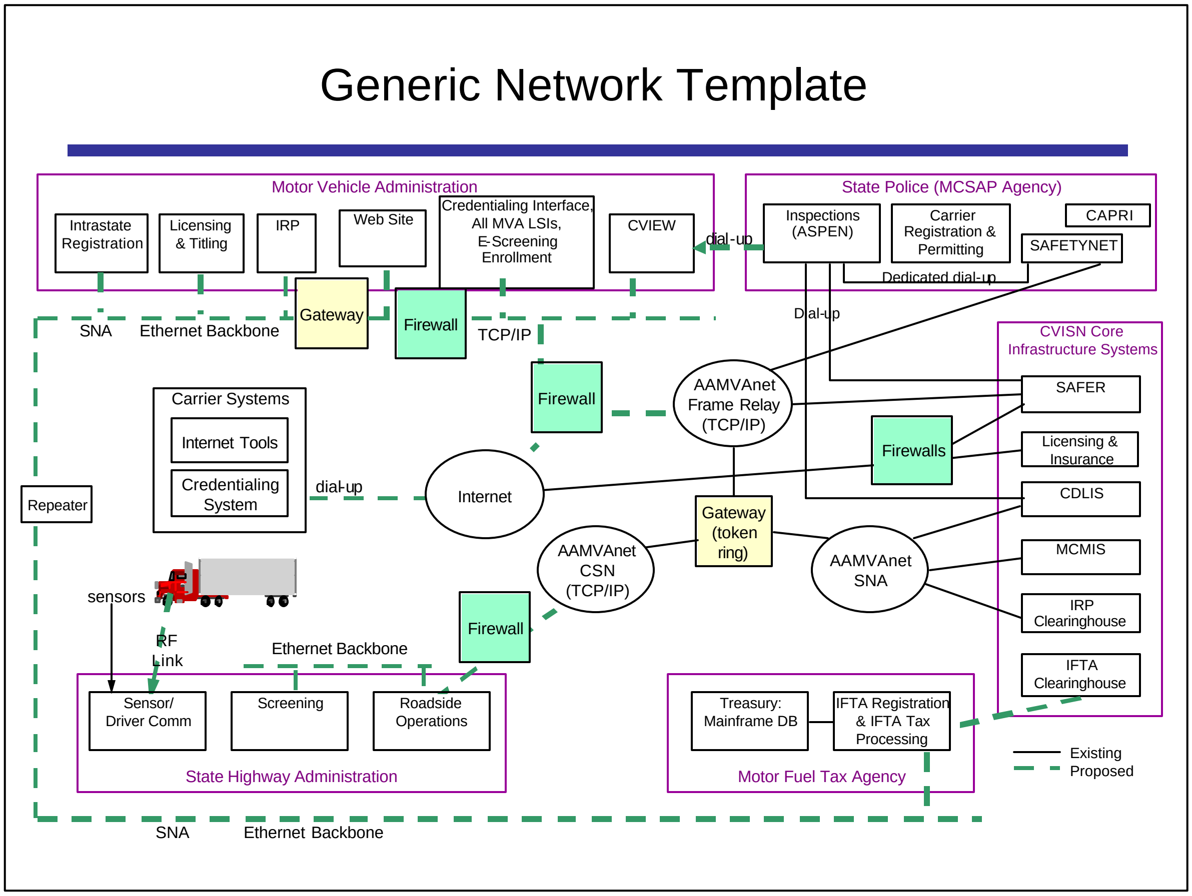

Figure 5-4. Generic Network Template

This template is used to show network connections, as well as the allocation of software products to computers. Proposed new computers and network connections can be added. As you make decisions, show which network protocols you've selected for each segment. The diagram can be used to verify how two or more systems are connected physically, and where network "translations" are needed. It can also show where potential bottlenecks exist.

On the network template, each small box represents a computer system. The state should show all the computer systems that support (or will support) the CVISN project functions. List the major functions (software applications) handled by that computer inside the box. Group the small boxes into large boxes according to the state agency or facility that is responsible for the computers. Show LANs and WANs as lines connecting the computers.

We recommend that you adopt some convention for distinguishing between existing and proposed computers and connections. For instance, you could make existing computers white, and new ones shaded. You could show existing connections as solid lines and new ones as dashed. Different dashed line types could indicate different network protocols.

Every function box on your state system design template should be allocated to some computer on this template. This includes each of the individual LSI boxes. Often for credentials-related products, the LSIs are small applications running on the same computer as the Credentialing Interface. LMs are modifications to existing systems, and usually are not shown as separately allocated functions on the network template.

5.4 Define Key Level 1 Scenarios (Step 4)

When we say that the next step is to define key operational scenarios, we mean that the state should describe how they intend that their customers and the state, or the state and core infrastructure systems should interact to accomplish key CVISN Level 1 functions. This is the most difficult and time-consuming part of the top-level system design process. **The following list represents key scenarios that are representative of the major CVISN Level 1 capabilities.** A more complete list of scenarios can be found in the CVISN Interoperability Test Suite Package, Part 1, Test Specifications (Reference 37). If you are implementing the complete set of CVISN Level 1 capabilities, then you should define each of these scenarios.

- Record inspections electronically and report them to SAFER and MCMIS
- Query for a past inspection report
- Maintain carrier and vehicle snapshots for intrastate operators
- Query for a snapshot
- Screen vehicles electronically at at least one weigh station/inspection site, using snapshots
- Enroll carrier and vehicles for electronic screening
- Accept and process electronic IRP credential applications for supplements (e.g., adding a vehicle to an existing account) (person-to-computer and computer-to-computer scenarios)
- Accept and process electronic IRP renewal applications (person-to-computer and computer-to-computer scenarios)
- Accept and process electronic IFTA credential applications for supplements (e.g., additional decals) (person-to-computer and computer-to-computer scenarios)
- Accept and process electronic IFTA renewal applications (person-to-computer and computer-to-computer scenarios)
- Accept and process electronic filing of and payment for IFTA quarterly tax returns (person-to-computer and computer-to-computer scenarios)

By the time a state is ready to define new operational scenarios, the project team has already characterized their existing systems, established project objectives, defined operational concepts and design guidelines, and taken first cuts at the state system design template and network template.

In the workshop methodology, operational scenarios are illustrated by overlaying information onto the state system design template. The resulting diagram (Figure 5-5) is sometimes called a "functional thread diagram." The diagram is augmented by text describing the operational process.

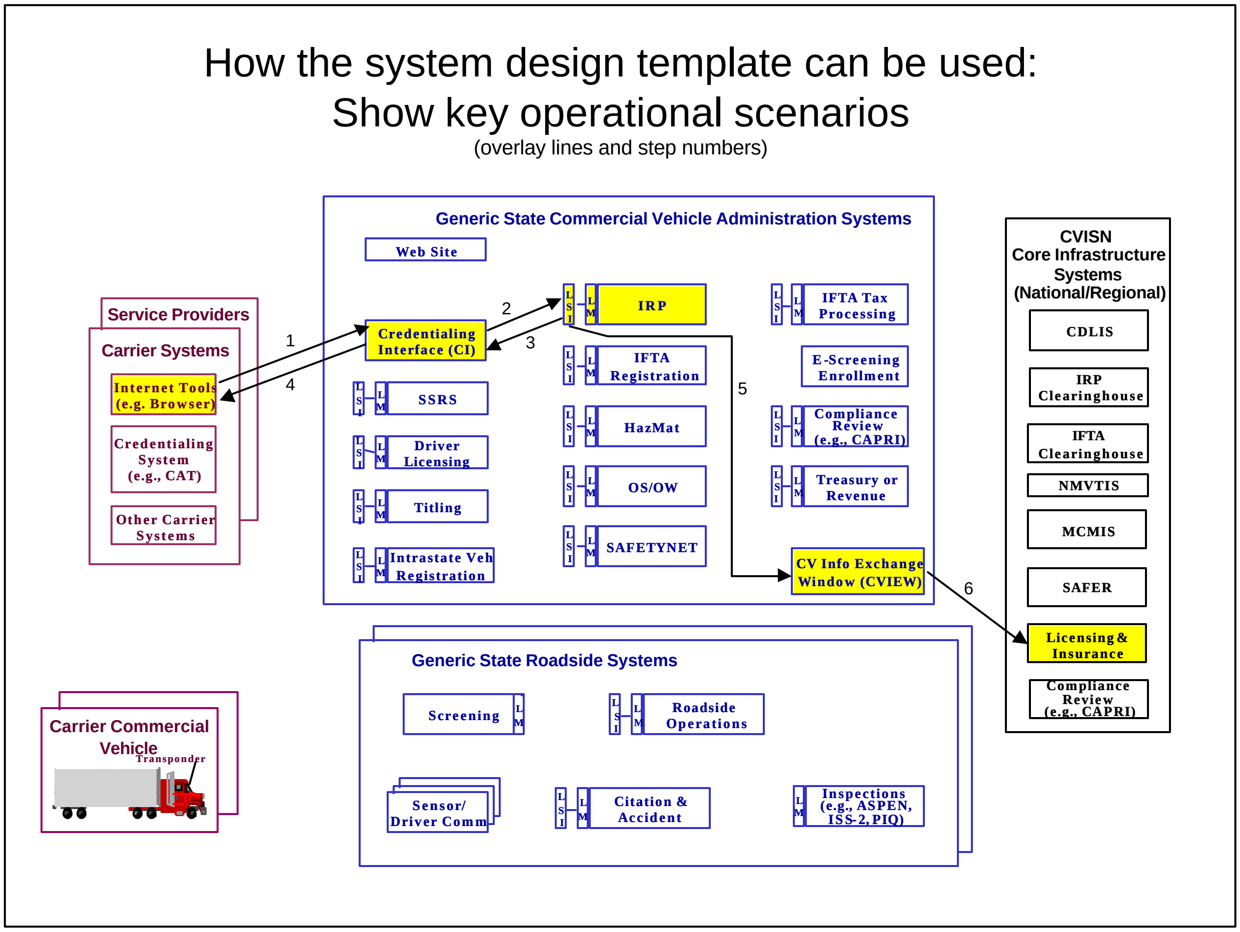

Figure 5-5. Operational Scenario (a.k.a. Functional Thread Diagram)

Use the project objectives and COACH Part 1 checklists as reminders of what your state intends to do. Assess options for implementing each scenario. Begin to identify where you need to use open standards (e.g., for interactions with carriers). The COACH Part 4 (Reference 5) provides a good overview of the CVISN interface specifications. For each legacy system involved in a particular scenario, decide whether you will modify the legacy product (LM) or construct a legacy system interface (LSI), or both. Consider what customer base are you most interested in supporting first for each scenario, and which option might be best for them. Assess the difficulty of implementing various design options. Recall the different approaches for evaluating alternatives (literature search, seek expert judgment, trade study, simulation, competition, prototyping) outlined in Module 2 of the Understanding ITS/CVO Technology Applications course Reference 29). While it isn't necessary to complete the process of evaluating alternatives at this stage, it must be done sometime to reach a final top-level design.

The mechanics of defining key operational scenarios involve a methodical step-by-step process. Work on one scenario at a time. For each scenario, list the steps in the scenario, keeping in mind the operational and design choices you've made. Use a copy of your state's CVISN system design template to show what functions will interact to support the operational scenario. Do this by drawing lines between boxes to show how your state's systems, the carriers' systems, and the CVISN core infrastructure will interact to support the operational scenario. Be sure to connect the right segments of each box. For instance, if you are going to construct an LSI, then connect to the LSI. Label the lines with the steps in the operational scenario. Use arrowheads to indicate flow direction. We call this drawing a "functional thread diagram."

Review the network template to see what new or enhanced processing power or connectivity is needed to support the interactions. As needed, add computers or connections to the network diagram. If a new process is being added to an existing computer, list the software application in that computer's box. Repeat the process until you have worked out each scenario. Always start with a clean, updated copy of each template.

The CVISN Level 1 scenarios listed earlier focus on successful interactions. As part of the process of defining how you want your revised systems to work, you must also consider error conditions and exceptions. One approach is to look at the basic scenario and ask "what if" questions (e.g., what if the connection between the carrier's system and the state's system drops out in the middle of a transmission?). You need to capture the reactions you want the system to make to error conditions and exceptions. The method you use may be to document more scenarios, or to describe in words how the system should handle errors and exceptions.

As you work on the scenarios, you may need to update the preliminary templates, by adding, removing, or renaming boxes on the templates, by moving applications from one computer to another, and/or by changing the network connections. Update the master and use the revised templates for subsequent scenarios. Revisit the scenarios you have already completed, and see if updates are needed. As you work on each scenario, you should identify issues that must be addressed to implement the scenario, or to complete the scenario definition. Keep track of decisions you still need to make, and which ones you have already made. The process of defining operational scenarios is iterative; don't expect to get any of them exactly right the first time. After you have completed all the functional thread diagrams, review them as a group, and make changes as needed to make the operational processes consistent. By using a systematic approach you will be testing the top-level design.

The Understanding ITS/CVO Technology Applications course (Reference 29) introduced the use of functional thread diagrams, and contains several examples. Several other examples are also shown in the Scope workshop workbook (Reference 34), and the CVISN Guides to Safety Information Exchange, Credentials Administration, and Electronic Screening (References 9-11).

5.5 Summarize System Interfaces (Step 5)

After completing the functional thread diagrams, it is possible to summarize system interfaces. This is illustrated in two ways. First, make three copies of the state CVISN system design template, one for “Carrier-Related Interfaces”, another “Interfaces within the State”, and a third “State Interfaces with CVISN Core Infrastructure.” See Figure 5-6.

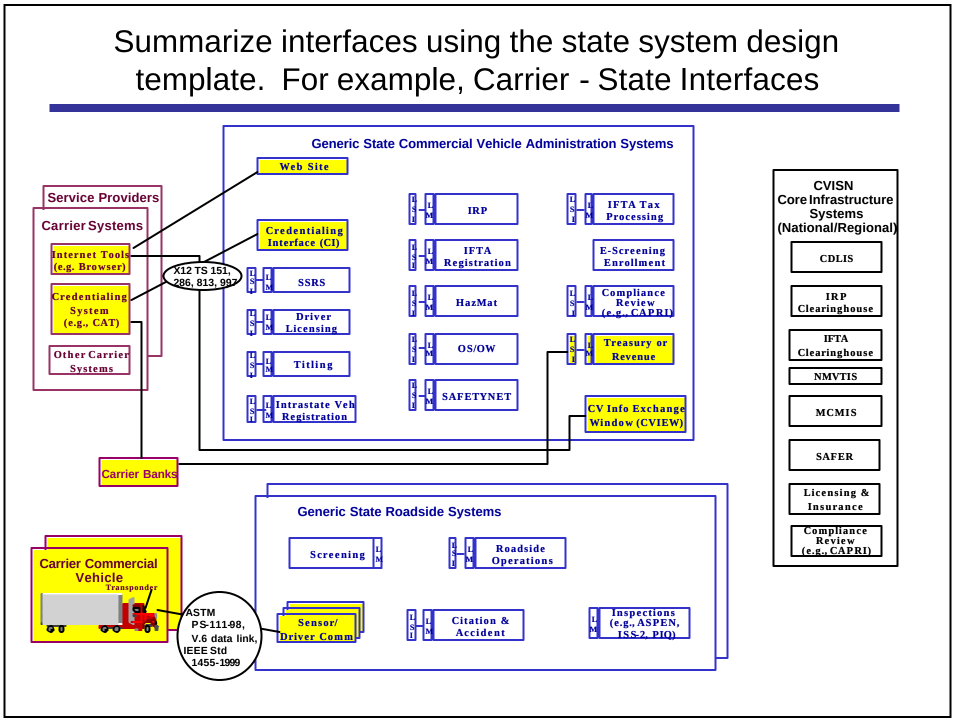

Figure 5-6 Summarize Interfaces Using the State System Design Template

Review the comparable figures for the generic state design in the *CVISN System Design Description*, Chapter 4, Putting It All Together (Reference 7). Next, review each of your state’s functional thread diagrams from step 4 of this top-level design process and draw lines connecting boxes on the appropriate interface diagram. Once you have connected two boxes because of one functional flow, you don’t have to add another line to the interface diagram. Instead, label the line with the interface standard(s) you intend to use between those two boxes. For instance, the X12 TS 286 is the interface standard for credentials exchanges between the carrier and the state. As with the functional thread diagrams, on each of these system design interface summary drawings, indicate whether legacy system interfaces (LSIs) or legacy modifications (LMs), or both, will be required for the functions being supported. The filled-in state system design templates are your top-level interface diagrams.

Then, reflect the operational scenarios in your network diagram. Show which computers will connect, and what networks and protocols will support those connections. The filled-in network template is your top-level physical system design. See Figure 5-7.

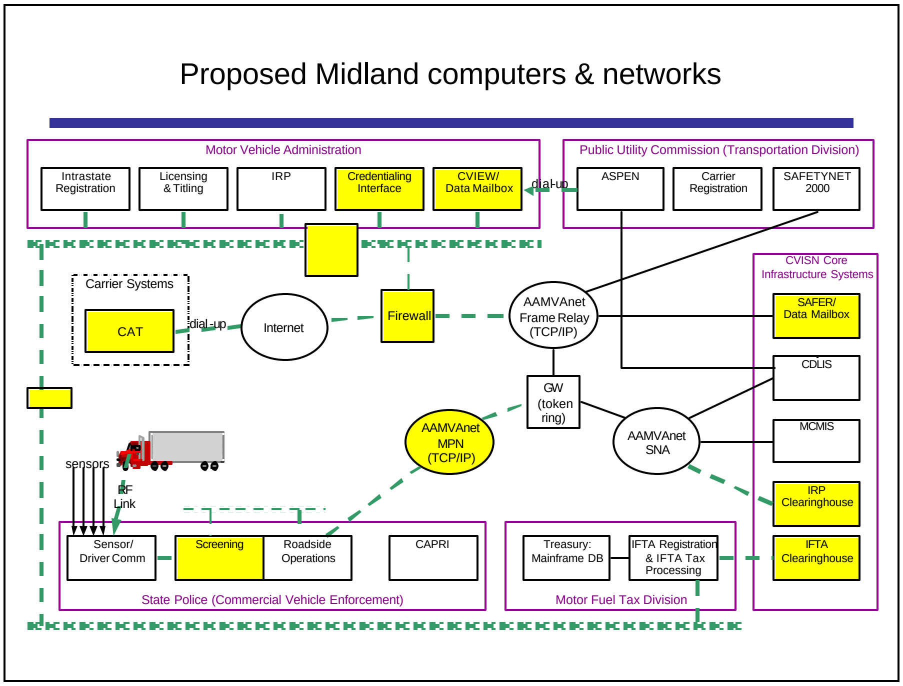

Figure 5-7. Physical System Design

5.6 Summarize System Changes (Step 6)

The final step of the top-level design process is to summarize the changes you expect to make to existing products and to describe new products required. In this step you should re-evaluate all that you have done so far and make sure that it is technically sensible. As part of that process, ask yourself these kinds of questions:

- Is it clear which design element is responsible for each aspect of each operational scenario? If not, are all open questions captured on the action list?
- Is the system partitioned into manageable elements? (Reference 35)
  - Are the elements as independent as possible? (low coupling)
    - Are there any unnecessary relationships?
    - Is the number of necessary relationships as small as possible?
  - Does each element carry out a single function? (high cohesion)
- Is any computer likely to be overloaded?
- Are there any communications bottlenecks?
- Should there be any redundant elements to assure that the system will be available to users as needed?
- If new requirements or new technologies emerge, will it be possible to modify the design without starting over?
- Are proprietary components used where standard components would suffice?
- Is the cost associated with this design within your available resources?
- Is the system testable?

In this step, you should identify the scope of the system changes/additions needed to become (more) compatible with CVISN to support the operational scenarios. As you assess the scope of the changes or additions, consider issues such as connectivity, interfaces, system capacity, data compatibility, process/policy changes, institutional barriers, cost, etc. Consider how to test the scenarios and the system, and how you will transition from the current design to the final design.

There are three primary aspects of the technical changes:

- Software products and interfaces between them
- Computers
- Networks

For roadside electronic screening, other site improvements that don't fall into these categories may also be required.

One way to summarize the changes is to make a descriptive list. The now-familiar templates and various uses of them also show summaries. Another way is to make a simple list and estimate whether the change/addition is Small, Medium, or Large.

Regardless of how the summary is shown, it is the beginning of a task list that can be used to generate a Work Breakdown Structure. Refer to the CVISN Guide to Program and Project Planning (Reference 43) and the materials for the ITS/CVO Technical Project Management for Non-Technical Managers training course (Reference 44) for further information about Work Breakdown Structures.

The process of summarizing changes should include these steps:

- Identify which software products will be changed and what new ones will be added to support the operational scenarios.
- Identify which computers will be upgraded and what new computers will be added to support the new or changed products.
- Identify which networks will be upgraded and what new connectivity is required to support the operational scenarios.
- Identify system test requirements.

5.7 Summary

The process described in this chapter was used by the CVISN Model Deployment states. It is the process we will use at the CVISN Scope Workshop. The workshop is intended to be both a process learning experience and a productive series of sessions that help you start defining your top-level design. When the project team returns home, the process should continue until the design is complete.

The development process should also include a review of the top-level design. Reviewers should include the conformance assessment team (COAT), the project team, state information technology experts, and system users. The COAT should check that the design conforms with the CVISN architecture and standards. The project team should check that the design fulfills the project requirements. The state information technology (IT) experts should check that the design meets IT guidelines for the state and is consistent with related projects. The users should verify that the design will improve their work environment and support operational requirements.

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6. REQUIREMENTS AND TOP-LEVEL DESIGN GUIDANCE

The U.S. Congress has mandated that the implementation of ITS using Highway Trust Funds authorized by the reauthorization of ISTEA (Intermodal Surface Transportation Efficiency Act of 1991), the Transportation Equity Act for the 21st Century (TEA-21), must be in conformance with the National ITS Architecture and Standards. Chapter 7, *How Do States Assure Conformance with the National ITS Architecture?*, of the Introductory Guide to CVISN (Reference 8) provides an overview of the Conformance Assurance Process. Details are found in the Conformance Assurance Process Description (Reference 36).

The requirements for CVISN are defined in the COACH (CVISN Operational and Architectural Compatibility Handbook). The COACH fundamentally requires deployed systems to adhere to open interface standards, support CVISN operational concepts, and use shared process and data definitions. The COACH documents are recommended as a relatively concise set of checklists to assist at various checkpoints. The COACH is divided into 5 parts:

- Part 1 - Operational Concept and Top-Level Design Checklists
- Part 2 - Project Management Checklists
- Part 3 - Detailed System Checklists
- Part 4 - Interface Specification
- Part 5 - Interoperability Test Criteria

Parts 1, 4 and 5 of the COACH specify conformance requirements. Parts 2 and 3 provide process guidance that is intended to help organize projects and develop designs that lead to systems that conform. In addition, for CVISN Level 1, the CVISN Guides to Safety Information Exchange, Credentials Administration, and Electronic Screening (References 9-11) contain specific advice about those functional areas.

The COACH Part 1, Part 3 and Part 4 checklists provide requirements and guidance for the top-level design. The checklists in the COACH Part 1 should be completed prior to attending the Scope workshop. During the top-level design phase (after the Scope workshop and before the Design workshop), the COACH Part 3 paragraphs describing each generic system component should be modified to reflect the functionality of the state-specific components. The COACH Part 3 checklists may be completed as well to allocate functions to each system component. The checklists in the COACH Part 4 should also be completed in the top-level design phase so that the top-level interface definitions are made as part of the top-level design.

Figure 6-1 illustrates the baseline and state-specific inputs to the development process. All should be considered when completing the top-level design.

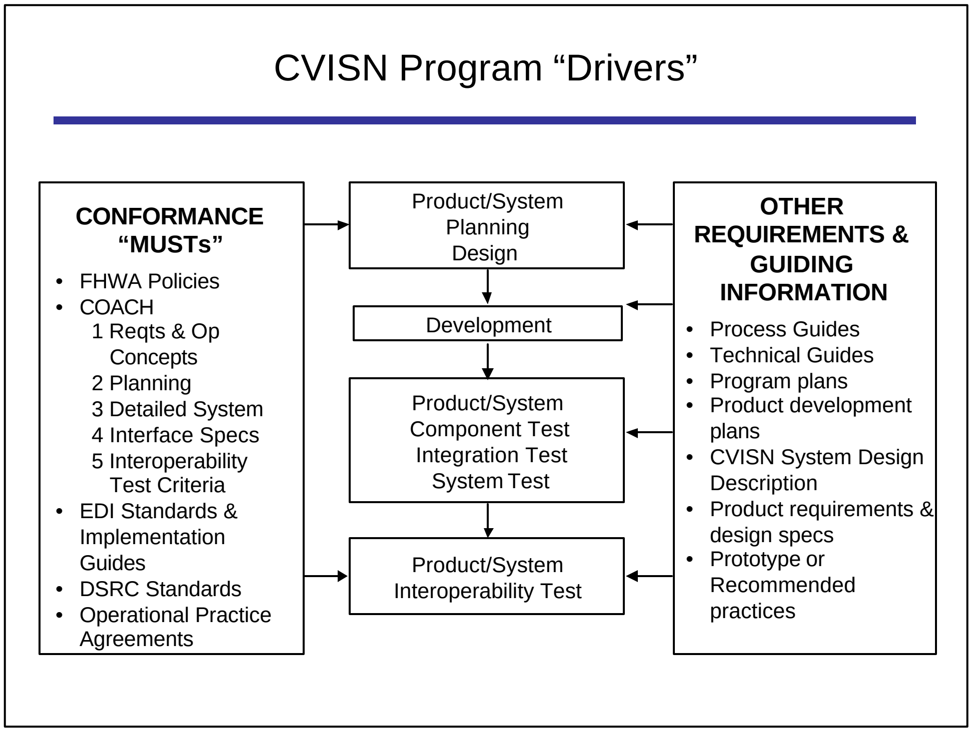

Figure 6-1. CVISN Program "Drivers"

The items labeled 'conformance "musts"' are associated with architecture conformance precepts. Adhering to the guidance in those documents will achieve these goals:

- Implementation of the operational concepts and practices expressed in the National Architecture and CVISN Architecture
- Capturing information efficiently and accurately at its source (e.g., ASPEN for inspections)
- Use of standard data definitions, including standard identifiers to facilitate the exchange of safety and credentials information between jurisdictions
- Use of open standards (e. g., EDI and DSRC) to communicate between public and private systems, and between jurisdictions via the CVISN Core Infrastructure
- Support of base state agreements through the established clearinghouses

Table 6-1 lists some of the major design decisions that each state must make to complete their top-level design. More about each of these decisions is provided in the *CVISN Guides to Safety Information Exchange*, *Credentials Administration*, and *Electronic Screening* (References 9-11).

Table 6-1. Critical Design Decisions

Safety Information Exchange	Credentials Administration	Electronic Screening
Will the state implement a CVIEW (or equivalent) system?	For which credentials will the state implement electronic credentialing?	Does the state already belong to or will it join an existing screening program?
Will the state build a CVIEW (or equivalent) from scratch or start with one of the existing models?	Are there some parts of a credential's process where automation is impractical or the benefit of automation isn't worth the cost?	Will electronic screening be performed at fixed sites? Mobile sites? Or both?
What functions will the CVIEW (or equivalent) system perform?	Will the state implement a computer-to-computer interface for electronic credentialing?	Which site will the state upgrade first to handle electronic screening?
Does the state use or intend to use ASPEN for inspections?	If the state elects to implement a computer-to-computer interface for carrier-to-state transactions, what interface method will be used (X12 EDI, XML, or other)?	At what other sites will electronic screening be deployed?
Will CVIEW act as the single interface system for ASPEN units in the field?	For each credential, will the state modify the legacy system (LM) to handle EDI, or translate the incoming transactions in a legacy system interface (LSI) and pass the credential application data to the legacy system in the native form?	Will the state deploy WIM on the mainline? On the ramp? Both? Neither?
Will credentials snapshot inputs come directly from legacy systems and snapshot go to legacy systems? Or from/to the legacy systems via the Credentialing Interface?	How will requirements be specified?	Will the state screen using both carrier and vehicle data?
In EDI format or some custom interface format?	How will snapshots be updated to reflect credentials actions?	What screening factors will the state use?

(Table 6-1 continued on next page.)

Table 6-1. Critical Design Decisions (Continued)

Safety Information Exchange	Credentials Administration	Electronic Screening
What systems in the state will provide snapshot segment updates?	Does the state plan to build a Credentialing Interface? Take another approach that doesn't involve a CI?	What is the state enrollment policy?
Will the state maintain intrastate snapshots?	Where and how will snapshots be used in the credentialing processes?	How will the state share enrollment information with other programs?
What snapshot views will be used where?	Where will error checks be performed?	
	Will the state provide a Web solution?	
	How can the state leverage the automation to help with paper forms processing?	

Not explicitly listed in the table are a variety of questions about the physical design of the state systems:

- What new computers are required?
- What enhancements are required to existing computers?
- What new network components are required?
- What network upgrades are required?
- What new general-purpose commercial software (e.g., operating system software, data base software) is required?
- What upgrades to existing software installations are required?

All these questions, and others unique to each state, should be addressed in the top-level design phase of the project.

7. PRODUCTS OF THE TOP-LEVEL DESIGN PROCESS

The top-level design process should result in a State CVISN Top-Level Design Description. Appendix B is a sample annotated outline for a State CVISN Top-Level Design Description. As shown in the appendix, it should contain this kind of information:

- Top-level requirements – Defines the top-level system requirements, software requirements, and interface requirements. The COACH Part 1 and Part 4 checklists are the basis for the requirements, supplemented as needed by state-unique goals, objectives, and requirements. Including the tables from the COACH Part 1 and Part 4 with the “Commit” columns filled in is recommended.
- Operational concepts and scenarios – Answers basic questions on what existing operational processes will be modified or what new ones will be added; what user interactions will be changed. Focuses on "what" and not "how." Including a series of operational scenarios (lists of steps) and accompanying functional thread diagrams is recommended.
- Top-level design – Defines the top-level design of the system hardware, software, and networks. The design includes high-level definitions of processes, data, system elements, and interfaces. The top-level requirements should be allocated to system elements. The top-level design will serve as the technical starting point for defining state-specific detailed interface requirements and product modification or development specifications. The design may be framed as diagrams, tables, and text. Summaries of interfaces should be included in the top-level design. Textual descriptions of the functions assigned to each system component should be included. Tailoring and completing the tables from the COACH Part 3, Appendix A, is also recommended.
- Summaries of changes – Describes, at a high-level, the scope of changes to existing systems implied by the top-level design. These summaries may be in the form of lists, diagrams, and/or tables.
- Open issues – Inevitably, some issues will be identified during the top-level design phase. Documenting the issues serves as a reminder to address them. Noting the resolutions as they are determined helps the team remember how and why a particular design solution was chosen. The issues are often stated in a separate chapter as a numbered list.

The State CVISN Top-Level Design Description should be a document accessible to the entire program team. It should be easy for all team members to read and understand, and easy to maintain. See Appendix B for a sample outline. In addition, examples of CVISN Model Deployment State designs can be found at their WWW sites (References 38–42). Many states included top-level design information in their CVISN Program Plans.

At the Scope workshop, you will start the top-level design process. The process cannot be completed with the limited team that attends the workshop, nor should the first drafts of templates, operational scenarios, interface decisions, and physical system design be considered as anything other than preliminary. Design is an iterative process that benefits from team-wide review. The design is the foundation for program planning. Summaries of interfaces and system changes form the beginnings of task lists. Recording design in a document that is easy to access, useful to the team, and easy to maintain is one of the keys to program success.

APPENDIX A.

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Appendix B.

State CVISN Top-Level Design Description Outline

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Note: This outline is provided as guidance for the breadth and depth of information that should be included in the State CVISN Top-Level Design Description. The material in this document should be sufficient to support the procurement process. Additional detailed requirements definition and detailed design efforts must be accomplished as part of the incremental development process.

1. Introduction

2. System Requirements
   - State-specific goals
   - COACH Part 1 tables from Chapters 2, 3, 4
   - COACH Part 4 tables
   - Other state requirements

The system requirements are based upon the project objectives and are very high level. The requirements other than the COACH Part 1 and 4 should be at most one or two pages.

3. System Design
   - Allocation of requirements to system components
     - Description of functions for each new or modified component (COACH Part 3, chapter 3)
     - COACH Part 3, Appendix A tables, tailored as needed (optional)
   - System Interface Summaries
     - Carrier-Related Interfaces
     - Interfaces within the State
     - State Interfaces with CVISN Core Infrastructure
   - Top-Level Physical System Design

   The COACH Part 3 is a tool for allocating the state requirements from the COACH Part 1 to particular elements of the system design. Text that explains the functions assigned to a new application may be supplemented by the allocation tables in Appendix A of the COACH Part 3.

   The system interface summaries are composed of diagrams that show all of the elements and connections for the state CVISN top-level system design. Three interface summaries are developed to show the carriers' systems and interfaces, the state's systems and interfaces, and the CVISN core infrastructure systems and interfaces. The system interface summaries show the major functions and the data interfaces.

   The completed network diagram presents the top-level physical system design. It shows the hardware and data communication interfaces with the physical interfaces protocols noted. The completed network diagram also shows which functions were allocated to each computer. The allocation of the functional requirements to the physical components shows how the system design is intended to meet the requirements. The physical system design diagram should be supported with descriptive material as needed to make the design clear.

4. System Change Summary

   The system change summary lists all of the systems and interfaces that need to be developed or modified to implement the CVISN project objectives. All changes are described and categorized as small, medium or large changes. New computers, networks, or software applications are identified. Testing required to verify the changes or newly-developed components is described.

5. Operational Scenarios

   The operational scenarios explain the interactions between major system elements that are required to execute key CVO activities. These scenarios serve as a basis for the system block diagrams. Include functional thread diagrams and text (list of steps) to explain each operational scenario that is part of your state's CVISN project scope. See chapter 5 of the CVISN Guide to Top-Level Design for the nominal list of scenarios that are part of CVISN Level 1.

6. Issues

   Issues that emerge during the top-level design process are noted here. As resolutions are decided, the resolutions are summarized here. The list serves as a tickler for action item assignments and concerns that should be addressed. The design should not reach "final" status until all issues have been resolved, dismissed, or until resolution of the issue has been assigned to some later stage in the development process.